R E P O R T R E S U M E S

ED 003 181 56

EFFECTS OF INSERTED QUESTIONS IN FILMS ON DEVELOPING AN UNDERSTANDING OF CONTROLLED EXPERIMENTATION.

BY- VUKE, GEORGE J.
INDIANA UNIV., BLOOMINGTON, SCH. OF EDUCATION

REPORT NUMBER NDEA-VIIA-657 PUB DATE FEB 62
GRANT OEC-712128
EDRS PRICE MF-$0.18 HC-$2.56 64P.

DESCRIPTORS- EDUCATIONAL RESEARCH, *MEDIA RESEARCH, *SCIENCE EDUCATION, JUNIOR HIGH SCHOOLS, *STATISTICAL ANALYSIS, *GRADE 7, FILMS, *INSTRUCTIONAL FILMS, COMPARATIVE ANALYSIS, *QUESTIONING TECHNIQUES, BLOOMINGTON, INDIANA

THE PURPOSE OF THE STUDY WAS THE DEVELOPMENT AND EXPERIMENTAL TEST OF TWO VERSIONS OF A SEVENTH-GRADE SCIENCE FILM. SPECIFIC OBJECTIVES WERE (1) TO PRODUCE TWO VERSIONS OF A FILM, ONE OF WHICH CONTAINED INSERTED QUESTIONS, AND (2) TO COMPARE THE EFFECTIVENESS OF THE QUESTIONS IN DEVELOPING AN UNDERSTANDING OF CONTROLLED EXPERIMENTATION. ALL OF THE SEVENTH-GRADE STUDENTS IN A PARTICULAR SCHOOL WERE RANDOMLY ASSIGNED TO ONE OF TWO GROUPS. THE STUDENTS WERE GIVEN A PRETEST, AND ON THE FOLLOWING DAY, AFTER SEEING ONE OF THE TWO FILM VERSIONS, THEY WERE GIVEN A POST-TEST. TWO WEEKS LATER A RETENTION TEST WAS ADMINISTERED. NO SIGNIFICANT DIFFERENCE OF LEARNING WAS FOUND. THE GAIN BETWEEN PRETEST AND POST-TEST SCORES WAS STATISTICALLY SIGNIFICANT AT THE .005 LEVEL. THE RETENTION TEST SHOWED NO SIGNIFICANT DIFFERENCE BETWEEN THE MEANS OF GROUPS. (HB)

ED003181

657 657

U. S. DEPARTMENT OF HEALTH, EDUCATION AND WELFARE
Office of Education
This document has been reproduced exactly as received from the person or organization originating it. Points of view or opinions stated do not necessarily represent official Office of Education position or policy.

FINAL REPORT

EFFECTS OF INSERTED QUESTIONS IN FILMS ON DEVELOPING AN UNDERSTANDING OF CONTROLLED EXPERIMENTATION

GEORGE J. VUKE
AUDIO VISUAL CENTER, EXTENSION DIVISION
DIVISION OF EDUCATIONAL MEDIA, SCHOOL OF EDUCATION
INDIANA UNIVERSITY

THE RESEARCH REPORTED HEREIN
WAS SUPPORTED BY A GRANT FROM THE
U. S. DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE
OFFICE OF EDUCATION

TITLE VII
NATIONAL DEFENSE EDUCATION ACT OF 1958
GRANT NUMBER 712128

FEBRUARY, 1962

EFFECTS OF INSERTED QUESTIONS IN FILMS ON DEVELOPING AN UNDERSTANDING OF CONTROLLED EXPERIMENTATION

George J. Vuke
Audio Visual Center, Extension Division
Division of Educational Media, School of Education
INDIANA UNIVERSITY

The Research Reported Herein
Was Supported by a Grant from the

U.S. DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE
Office of Education

Title VII
National Defense Education Act of 1958
Grant Number 712128

February, 1962

TABLE OF CONTENTS

Chapter		Page
I.	INTRODUCTION	1
	Background of the Study	1
	Purposes of the Study	4
	Analysis of the Problem	5
II.	REVIEW OF RELATED RESEARCH	9
III.	EXPERIMENTAL DESIGN AND PROCEDURES	16
	Production of the Films	16
	Differences Between the Two Final Film Versions	22
	Preparation of the Test	25
	Test Validity	27
	The Pilot Study	28
	Test Item Discrimination and Item Difficulty	29
	Test Reliability	30
	Test Population	30
	Division of Students into Groups	32
	Description of the Experiment	33
IV.	ANALYSIS OF DATA AND RESULTS	36
V.	CONCLUSIONS	47
	BIBLIOGRAPHY	49
	APPENDIX	52

LIST OF TABLES

Table		Page
1.	Average Discrimination and Difficulty Indices Determined from Responses to Test Administered to Pilot Group	29
2.	Results of t Test of Significance as Applied to Hypothesis 1	40
3.	Results of t Test of Significance as Applied to Hypothesis 2	41
4.	Results of t Test of Significance as Applied to Hypothesis 3	42
5.	Results of t Test of Significance as Applied to Hypothesis 4	43
6.	Results of Mann-Whitney U Test as Applied to Hypotheses 5, 6, 7 and 8	44
7.	Mean Gain in Scores from Pretest to Post-Test for Each of Four I.Q. Groupings	44
8.	Results of Calculation of Means in Each of Four Test Item Categories	45

CHAPTER I

INTRODUCTION

Background of the Study

Most science educators agree that science has two aspects: (1) the static or conservative aspect which is concerned with acquisition of facts, principles and concepts that have been handed down from past generations; and (2) the dynamic aspect which is known by names, such as, problem solving, logical reasoning, experimental and scientific method.

Science educators subdivide these two aspects into four general objectives of science teaching: (1) acquisition of factual information in science, (2) understanding and application of the principles of science, (3) skill in the basic tools peculiar to a specific science, and (4) understanding and application of the elements of the scientific method together with its associated attitudes.

There is general agreement that the fourth objective, often referred to as the scientific method or problem solving objective, is extremely important. (17:20; 22:257; 2:9)* However, science educators recognize that few teachers make a direct effort to achieve this objective (17: 32; 18:1) and have indicated that the scarcity of helpful

---

*Numbers in parentheses refer to numbered references in the bibliography; those after the colon are page numbers.

published materials is a prime reason teachers are reluctant to teach specifically for this objective. (3:65; 18:2)

Many researches have shown that educational motion pictures can teach factual information; and for many years science teachers have used the motion picture for this purpose. But there has been very little investigation of the effectiveness of educational motion pictures in helping to achieve the problem solving objective. One of the conclusions of Keeslar in his study of 1945 was that the prime objective of those who produced the high school science films which he studied was to dispense information. He recommended that teaching films be produced which are more definitively organized to teach the scientific method, and that the potentialities of motion pictures for teaching the elements of the scientific method and scientific attitudes be deliberately and thoroughly explored. (13:242)

The writer has previewed hundreds of educational motion pictures which have been released in the past ten years. Most of these had a natural science content and an intended primary audience of junior and senior high school science students. Most of the natural science films which were previewed seemed to have as their main objective the presentation of factual information, while the problem solving objective deemed so important by science educators received very little attention.

A survey of the literature disclosed that only a few

scattered studies, which will be discussed later, dealt with the use of films in achieving the problem solving objective.

It was primarily the above factors that prompted the writer to explore in this study the effectiveness of motion pictures in helping to achieve certain aspects of the problem solving objective.

Educational psychologists recognize the importance of predispositions to response; that is, if the subject is prepared or "set" for the stimulus, this may alter the stimulus-response relationship that might otherwise prevail. One way of preparing the subject is to precede the communication with a question designed to evoke an overt or covert response related to the material to be learned. This participation in the communication may result in increased learning.

According to Allen, during the past decade, no single variable in audio-visual use has been studied as intensively as that of participation; and no other variable has elicited a more general confirmation as a means for facilitating learning. However, he goes on to state that the technique of mental practice (covert participation) has been inadequately studied and may be a highly effective learning device. (1:423)

Maccoby (16) found that covert response, or thinking the answers to questions concerning information in the films studied, was as effective as overt response or writing the answers.

The importance given to mental set by educational psychologists and the potentialities of covert participation as a learning device in films led the writer to design this study to test experimentally the effectiveness of covert participation when viewing a film designed to teach certain elements of the scientific method. In addition, the writer was interested in determining whether or not a relationship existed between intelligence and the effectiveness of covert participation when viewing a film with the above-mentioned purposes. Consequently, the existence of this relationship was tested.

The Purposes of the Study

The two major purposes of this study were (1) to produce two versions of a film, one of which contained inserted questions while the other did not, and (2) to compare experimentally their effectiveness in developing a basic understanding of controlled experimentation. The second purpose stated as a question is as follows: "Does a significantly greater understanding of the basic requirements for a good planned experiment result from a film containing inserted questions followed by time intervals for covert response than from a film which contains no inserted questions?"

The subjects for the experiment were students in seventh grade general science.

Each of the two film versions was designed to develop an understanding of the following four basic requirements for a good planned experiment:

1. There must be two parts to compare, an experimental part and a control part.
2. There must be only one difference between the experimental part and the control part.
3. There must be many samples in both the experimental part and the control part.
4. The conclusion must not include more than the experiment allows.

Analysis of the Problem

Statement of the hypotheses. Since the test results of the two groups of students used in this experiment were to be analyzed by statistical methods, it was desirable to state the purposes of the experiment in exact hypotheses. This would permit the analysis of the test results by the appropriate tests of significance and would enable the determination of whether any differences in test results between the two groups could have been attributed to differences between the two films or to errors in random sampling.

The null hypotheses were as follows:

1. There is no significant difference between the mean pretest scores of the question film group and the statement film group.

2. The mean post-test score of the question film group is equal to or less than the mean post-test score of the statement film group.

3. The mean post-test score of the combined question film group and the statement film group is equal to or less than the mean pretest score of the combined groups.

4. The mean retention test score of the question film group is equal to or less than the mean retention test score of the statement film group.

5. The mean post-test score of the high I.Q. subjects in the question film group is equal to or less than the mean post-test score of the high I.Q. subjects in the statement film group.

6. The mean post-test score of the medium high I.Q. subjects in the question film group is equal to or less than the mean post-test score of the medium high I.Q. subjects in the statement film group.

7. The mean post-test score of the medium low I.Q. subjects in the question film group is equal to or less than the mean post-test score of the medium low I.Q. subjects in the statement film group.

8. The mean post-test score of the low I.Q. subjects in the question film group is equal to or less than the mean post-test score of the low I.Q. subjects in the statement film group.

Tests of significance. The t test of significance

was used to test hypotheses one, two, three and four. The purpose of hypothesis one was to discover whether the two groups referred to in each of the first four hypotheses could have been drawn from the same population; consequently, the two tailed test of significance was used to test this hypothesis. The major concern of this experiment as expressed in hypotheses two and four was with the direction of the difference between the two groups rather than its existence in absolute terms. The writer predicted in advance of the experiment that, in each case, the mean score of the question film group would be significantly greater than that of the statement film group; consequently, the one tailed test of significance was used to test these two hypotheses. Also, the writer predicted in advance of the experiment that the mean post-test score of the combined statement and question groups would be significantly greater than the mean pretest score of the combined groups; consequently, the one tailed test of significance was used to test hypothesis three.

The nonparametric Mann-Whitney U test was used to test hypotheses five, six, seven and eight. The one tailed test of significance was applied to these four hypotheses.

Experimental design. The experiment was of a simple, randomized design. All of the seventh grade students in a particular school were assigned to one of two groups by using a table of random numbers. The students were given

a pretest; and the following day, after seeing one of the two film versions, they were given a post-test. Two weeks later, a retention test was administered.

CHAPTER II

REVIEW OF RELATED RESEARCH

Research related to this study is reviewed in three sections: (1) research to determine the elements of the scientific method, (2) research concerned with the use of films to develop problem solving ability, and (3) research concerned with various types and degrees of viewer participation in films.

Research to Determine the Elements of the Scientific Method

The earliest researches to determine the elements of the scientific method were conducted in 1928 by Downing (8) and in 1933 by Weller (23). However, neither of these distinguished scientific method from scientific attitudes.

In 1934 Curtis (5) was the first to list the elements of the scientific method as distinct from scientific attitudes. He validated a list of ten elements by submitting it to twelve teachers of pure science at the University of Michigan.

In 1936 Crowell (4) surveyed the literature and compiled a list of 29 attitudes and 25 skills considered important for persons employing the scientific method. These lists were incorporated in a questionnaire which was sent to 122 persons who were science teachers in teacher training schools or in public schools and were listed in

the National Association for Research in Science Teaching. From 62 questionnaires returned, he developed a list of 23 skills considered essential to the scientific method.

A carefully determined list of the elements of the scientific method was the result of research in 1945 by Keeslar. (13) He prepared an original list of the elements of the scientific method based on a survey of the literature on the subject of the scientific method. The list was submitted for validation to 22 research scientists on the University of Michigan staff. The evaluations were tabulated, and each item was given a numerical value based on a 200 point scale. Twelve elements which fell below a designated point on the scale were eliminated, and the remaining 42 items were condensed and reorganized to form a final list of 10 major and 17 minor elements of the scientific method. The list was further checked for ambiguities by three specialists in the teaching of science and resulted in a final list expressed in a vocabulary suitable for use at college or university levels.

This list was reworded and revised by three experts in the teaching of science until they agreed that it was suitable for use by pupils in the seventh and eighth grades.

In 1956, Barnard and Obourn (19) prepared a comprehensive list of problem solving attitudes and problem solving abilities which can be developed through science

teaching. They presented their list in outline form with seven major headings and detailed sub-headings.

Comparison of the lists of Curtis, Crowell, Keeslar and Barnard and Obourn indicated considerable agreement concerning the elements of the scientific method and the related skills.

This study is chiefly concerned with those elements of the scientific method which deal with controlled experimentation, and this aspect of the scientific method is a part of all of the above mentioned lists.

Research Concerned with the Use of Films to Develop Problem Solving Ability

The writer could find very few researches concerned with the use of films to develop problem solving ability or to teach an understanding of the elements of the scientific method. However, three investigations which are related to this study will be described briefly.

In 1932 Rulon (22) compared the effectiveness of motion pictures and textbooks in teaching rote items and eduction items to ninth grade students. There were two controls groups: one consisted of 450 children who studied the text alone; the other consisted of 300 children who received no instruction at all. The experimental group which consisted of 1,200 children saw the motion pictures and studied the text. Rulon concluded that the gains in

knowledge of subject matter attributed to the films were not made at the expense of more important educational values, such as, habits of good thinking. He also stated that the eduction items appeared to be more desirable as educational aims and a more acceptable measure of the film superiority.

Keeslar (13) analyzed the contents of 24 science films, which were rated "excellent" in two current catalogs of teaching films, to determine, among other things, the contribution of the films to the major objectives of science teaching. He concluded that even the best films in science do not adequately provide for the teaching of the elements of the scientific method. No evidence was discovered which indicated that the producers who prepared the films of the selected list had been aware that the method of inquiry was a vital aspect of science. The motion pictures were replete with scientific facts but deficient in the exposition of the method used to discover these facts. Keeslar thought that it was reasonable to infer that the prime objective of those who produced the instructional films analyzed was, quite simply, to dispense information.

In 1958, deProspo (7) conducted a study with the major purpose of determining if active response to selected motion pictures by identification of the problem solving skills they portray reinforces or develops the scientific attitude of "suspended judgment."

The population for this investigation consisted of all the 240 students enrolled in General Biology I and General Science I at Seton Hall University. The students were randomly divided into the following three groups: (1) Experimental Group, (2) Film Control Group, and (3) No Film Control Group.

The experimental period lasted for one week and covered three class sessions. The Film Control Group spent the time just viewing the films; the No Film Group had routine classwork; while the Experimental Group was made aware of the experiment, received prior motivation, was required to identify problem solving skills as they were portrayed in the film, and answered specific questions concerning these skills on a specially prepared worksheet.

His findings showed (1) a significant gain in attitude in each of the film groups and a negligible gain in the No Film Group, (2) no significant differences between the means of the experimental group and the two control groups, (3) the change in attitude was not related to scholastic aptitude or to the ability to identify the problem solving skills, and had a moderate negative relationship to the opinion of the scientists portrayed, and (4) the change in attitude also had a slight correlation with the science preferences being positive for the No Film Group and negative for the film groups.

In his summary, deProspo stated that this investi-

gation provided a first indication that films can be used effectively to develop scientific attitudes at the college level.

Research Concerned with Various Types and Degrees of Viewer Participation in Films

A number of research studies have been concerned primarily with factors that affect the degree to which an audience is involved in a film presentation. Notable among these researches are those of Hall (9); Lumsdaine, May and others (15); Kurtz, Walter and Brenner (14); Roshal (20); Jaspen (11); Maccoby (16); Harby (10); and Kantor (12). Those interested in examining summaries of the above researches and related ones are referred to Allen (1).

It should be noted that some of the above studies do not agree in regard to the merits of covert participation in films. For example, Maccoby found that both overt and covert participation resulted in significantly greater improvement in learning than merely viewing the film. Kantor found no significant difference in learning between the group which participated covertly and those which merely viewed the film.

Also, it should be noted that all of the above studies used existing films; thus the places where the questions could be inserted were predetermined by the construction of the film. In addition, all of the films used

in these studies were concerned with factual information or motor skills.

CHAPTER III

EXPERIMENTAL DESIGN AND PROCEDURES

This chapter has been divided into the following sections: (1) production of the films, (2) differences between the two final films, (3) preparation of the test, (4) test validity, (5) the pilot study, (6) test item discrimination and difficulty, (7) test reliability, (8) description of the population, (9) division of students into groups, and (10) description of the experiment.

Production of the Films

The two films necessary for this study had to meet the following criteria:

1. The primary purpose of both films needed to be the development of an understanding of the four basic requirements for a good, planned experiment.

2. The content of the film versions, the treatment of this content and the level of the narration needed to be appropriate for seventh grade students.

3. One of the film versions needed to have inserted questions at selected intervals; and the other, no inserted questions.

4. The technical quality of the visuals and narration needed to be high.

After searching the major catalogs of film libraries

and film producers, consulting persons who were familiar with many of the science films that had been produced, and examining notes the writer had taken while previewing science films, no films could be found that would meet these criteria or could be altered readily to meet them. Consequently, the writer decided to produce the films himself and felt qualified to do so because of his ten years of experience in the production of educational motion pictures, including major roles in the production of 11 motion pictures with natural science content.

Since the purpose, audience and major content of the films had been determined previously, the next step was the choice of a treatment for the content. The film versions needed to develop an <u>understanding</u> of the four basic requirements for a good, planned experiment and not merely a rote recall of them, so the films had to do more than just present these requirements. After careful consideration, the writer decided that an effective procedure for developing an understanding of these four basic requirements would be to pose a question, present several experiments to answer the question, and evaluate the merits of each experiment.

In order to assist the writer in the choice of a suitable question to pose and experiments to present, four criteria were listed which the question and experiments needed to meet:

1. They must clearly demonstrate the four, basic requirements for a good, planned experiment.
2. They must be straightforward, devoid of confusing side issues.
3. They must be simple enough so that the film could be produced within the time and money budgets.
4. They needed to be familiar to seventh grade students so that the viewers would concentrate on procedure rather than outcome.

After examining general science textbooks, publications devoted to descriptions of science experiments, and other sources, it was decided that the question, "Do Seeds Need Water to Sprout into Plants?" and experiments designed to answer the question would meet the above criteria.

The next step in the production of the two film versions was the development of the scripts and storyboards. In the first draft of the two scripts, each scene was visualized by a drawing; then these script-storyboards were discussed with two junior high science teachers, the head of a junior high-senior high science department, two motion picture production supervisors, and a former junior high general science instructor who was devoting twenty hours per week to the evaluation and description of science films. These discussions resulted in the revision of several scenes, and these revised scripts became the shooting scripts.

For shooting purposes, the scenes were divided into two categories: (1) live action scenes, and (2) title scenes. The live action scenes were shot in the motion picture studio of the Indiana University Audio-Visual Center using the 16 mm, professional Maurer camera. The title scenes were lettered with a mechanical lettering device using black ink on clear acetate. The titles were shot against a gray background on the professional Oxberry animation stand. All of the footage was shot on Eastman Plus X Reversal film.

After the live action scenes and the title scenes were shot, the footage was processed; and the best scenes of this original footage were selected to be printed. This print, called a workprint, was used for editing purposes. After many days of editing the visuals and refining the narration, the question film was ready to be shown to the evaluators.

The film was shown to a number of evaluators including three with experience in junior high school science teaching and three with experience in educational motion picture production. When the question film was presented to the evaluators, the writer read the narration as the film was projected. Discussions with the evaluators following the presentation of the film resulted in the re-editing of several scenes and the revision of parts of the

narration.

After the film was revised, it was sent to a film laboratory for conforming of the original footage to the edited workprint. A duplicate negative was made from this conformed original footage; and a positive print was made from the negative. Then, the positive print was magnestriped. When the magnestriped positive print was received from the laboratory, it was projected to evaluate sharpness and exposure of visuals and placement of optical effects. The print was excellent from all these standpoints.

In order to conduct the pilot study, it was essential that the narration be recorded on the magnestripe of the question film. The narrator was chosen from among 26 individuals who had auditioned for the role of film narrator. Persons experienced in motion picture production and sound recording had judged his voice to be intelligible, pleasing and adaptable. The Eastman Pageant magnetic projector was used to record the first narration for the question film in the motion picture studio of the Audio-Visual Center, Indiana University.

During the pilot study, the film was projected in a semi-darkened room using the Eastman Pageant magnetic projector and was viewed by a class of 41 students. When the film was projected, the writer checked for clarity of visuals and sound from various positions in the room; both were highly satisfactory.

After the pilot study was conducted, the edited workprint for the question film was re-edited into the statement film. To do this, seven scenes containing question titles had to be removed; and two sequences of statements had to be substituted for two sequences of questions. The other scenes were retained without alteration.

When the editing of the statement film workprint was completed, it was checked by three of the aforementioned evaluators of the question film, using the previously described procedure. They suggested no changes in the visuals, but suggested a few, minor changes in the narration. The writer then edited the original footage (from which the question film was printed) to match the edited workprint of the statement film. This conformed original roll was sent to a film laboratory where a duplicate negative and a magnestriped positive print were made. When previewed by the writer, the positive print of the statement film was considered comparable in quality to the positive print of the question film.

It was essential that the sound tracks of each of the two film versions be as identical as possible except for the variable under study. To do this, it was decided to record on 16 mm magnetic film (1) the narration of the question film, and (2) the narration of the two statement sequences which were to be substituted for the question sequences. This was done by using professional sound

equipment in a sound recording studio and the same narrator discussed previously. The narration for the question film was then transferred from the 16 mm magnetic film to the magnestripe on the question film print by using professional sound equipment and a Bell and Howell magnetic projector.

The 16 mm magnetic film was then edited to form the narration for the statement film. This involved the removal of seven questions and the substitution of the statement narrations for the question narrations in the two sequences previously mentioned. After editing the magnetic film, the narration was transferred to the magnestripe of the statement film by using the same technique that was used for transferring the narration of the question film.

After the sound tracks were transferred to the magnestriped films, sound intelligibility and picture clarity for both films were compared by the narrator, the sound recordist and the writer. There was no detectable difference between the two films in sound quality or picture quality.

Differences Between the Two Final Film Versions

The final question film version and the final statement film version differed in two respects:

1. The question film had inserted questions followed by a time interval for covert response, while the statement film had no inserted questions.

2. The question film was 1.5 minutes longer than

the statement film.

Inserted question difference. The following illustrates the difference between the two films when a question inserted in the question film was eliminated in the statement film:

QUESTION FILM VERSION

Scene number	Visuals	Narration
10.	MS of flower pot with no sprout.	We cannot tell why the seed did not sprout because our experiment was poorly designed.
11.	Title: HOW WOULD YOU IMPROVE THE EXPERIMENT?	How would you improve the experiment? (Five second pause)
12.	MS of two flower pots, a packet of seeds, a flat of soil and a watering can--all on a table top.	This time to improve our experiment we use two similar flower pots instead of one.

STATEMENT FILM VERSION

10.	MS of flower pot with no sprout.	We cannot tell why the seed did not sprout because our experiment was poorly designed.
11.	Omit	
12.	MS of two flower pots, a packet of seeds, a flat of soil and a watering can--all on a table top.	This time to improve our experiment we use two similar flower pots instead of one.

The following illustrates the difference between the two film versions when a statement is substituted for a

question:

QUESTION FILM VERSION

Scene number	Visuals	Narration
9.	Title: WHY DIDN'T THE SEED SPROUT?	Why didn't the seed sprout? (Five second pause)
9a.	WHY DIDN'T THE SEED SPROUT? YES NO PERHAPS NO WATER	Because it wasn't watered? (Five second pause)
9b.	WHY DIDN'T THE SEED SPROUT? YES NO PERHAPS NO WATER X	Perhaps this is the reason.
9c.	WHY DIDN'T THE SEED SPROUT? YES NO PERHAPS NO WATER X DEAD SEED	Because the seed was dead? (Five second pause)
9d.	WHY DIDN'T THE SEED SPROUT? YES NO PERHAPS NO WATER X DEAD SEED X	This is also possible.

STATEMENT FILM VERSION

9.	Title: POSSIBLE REASONS FOR SEED NOT SPROUTING:	There are several possible reasons for the seed not sprouting.
9a.	POSSIBLE REASONS FOR SEED NOT SPROUTING: NO WATER	Perhaps the reason is because it wasn't watered.

9b. POSSIBLE REASONS FOR SEED NOT SPROUTING:

NO WATER
DEAD SEED

It is also possible that the seed was dead.

Time difference. The final question film version had 18 questions; each of the questions was read by the narrator as it appeared on the screen. After the narrator had finished reading each question, there was a five-second interval for covert response. Because of the inserted questions and the time intervals for covert response, the final question film was 1.5 minutes longer than the statement film. However, this variable was recognized as being necessary when the study was begun; and it was felt that the difference in time was justified because (1) the difference in time was recognized as a second variable; thus the study was comparing the effectiveness of two film versions that differed in length by 1.5 minutes; (2) if the question film resulted in statistically greater learning than the statement film, the film user would probably be willing to sacrifice an additional 1.5 minutes; and (3) the difference in time was not appreciable.

Preparation of the Test

The major purpose of each of the film versions was to develop an understanding of the four basic requirements for a good, planned experiment; consequently, a test needed

to be developed that would measure the student's understanding of all four of these requirements. Since care had to be taken to exclude test items that could be answered correctly from rote memory alone, items were constructed which were based on experimental situations. An objective 44-item test was constructed which had five parts; a sixth free response part was added also which was not used in the final calculations but as a further check of test validity.

In order to select the experiments to be presented in the test, the writer examined many elementary, junior high and senior high science textbooks, publications dealing with science teaching methods, and publications devoted entirely to experiments in science. From a long list of experiments, the writer selected five, which with some modification, would form a basis for testing an understanding of the four basic requirements for a good planned experiment.

Each of the first three parts of the test presented an experimental design, the results of the experiment, and the conclusions of the experimenter. The test items referred to the experiment that had been described in that part of the test. Each of the experiments violated one of the four basic requirements for a good planned experiment; for example, the first experiment had only one part; the second experiment had two parts but too few samples; and the third experiment had more than one difference between

the two parts. At least two of the four basic requirements for a good, planned experiment were tested in each of the three parts.

Test Validity

As a preliminary check for ambiguities and validity, the test was given to one of the writer's daughters who was just completing fifth grade as a superior student. After taking the test, she was asked questions which probed the reasons for her answers to each item. These discussions pointed out ambiguities resulting in misinterpretations of certain items; subsequently, several items in the test were revised.

The revised test was submitted to four Indiana University faculty members for their evaluation. Three of the four had taught junior high students; the fourth had a high interest in the education of junior high students and was engaged in research involving seventh grade students.

A sheet was attached to the test requesting the evaluators criticisms in three major categories:

1. The ability of each test item to measure an understanding of at least one of the four basic requirements for a good, planned experiment.

2. Ambiguities in the wording of the test items.

3. Notation of words which, in their opinion, would not be familiar to most seventh grade students.

The test items were discussed with each of the evaluators individually after which the second test revision was made. It was this revision that was used in the pilot study.

The Pilot Study

Before the experiment was conducted, it seemed necessary to conduct a pilot study for the following reasons: (1) to provide a basis for determining the discrimination and difficulty indices for each test item; (2) to provide a basis for determining test reliability; (3) to check experimental procedures; and (4) to provide a further check of the clarity of the visuals and narrations of the two film versions.

Forty-one sixth grade pupils participated in the pilot study which was conducted two weeks prior to the close of the school year. The test was administered to the pupils on a Wednesday; and the next day, the question film version was shown to them. Immediately following the film showing, the same test was administered again.

During the administrations of the test, several of the testees asked questions concerning the meanings of certain phrases used in the test. Some of these questions resulted in the rephrasing of certain test items when constructing the final test.

Test Item Discrimination and Difficulty

The responses of the pilot group to each of the test items were analyzed using the Davis formulas (6) for computing the proportions of successes in the highest and lowest 27 per cent of the sample. The figures obtained from these formulas include a correction for chance and omission of test items. The two figures obtained provide the basis for entering the item analysis chart to determine discrimination and difficulty indices.

The two indices were found for each test item. The following are the average indices for each part of the test and all parts combined:

TABLE 1. AVERAGE DISCRIMINATION AND DIFFICULTY INDICES DETERMINED FROM RESPONSES TO TEST ADMINISTERED TO PILOT GROUP

Part of test	Discrimination index	Difficulty index
Part A	.42	.52
Part B	.51	.54
Part C	.42	.51
Part D	.30	.60
Part E	.45	.43
All parts	.41	.52

Four items in Part D had discrimination indices which were within a few points of the minimum index of .20 recommended by Davis, and one item in Part E had a negative

discrimination index. New items were constructed to replace these, and an additional item was added. These six new items were validated by two of the aforementioned evaluators.

The final test consisted of seven parts which included 31 multiple choice items, 14 true-false items and one free response item. A copy of the final test is in the Appendix.

Test Reliability

The Kuder-Richardson formula for determining test reliability was applied to the scores of the pilot group on the 44-item post-test. The coefficient of reliability was found to be .840.

The coefficient of test reliability also was computed by using the post-test scores of the 81 subjects participating in the experiment and was found to be .835.

The scores of the combined question group and statement group on the 45-item post-test ranged from 15 to 44 correct responses, with a mean of 30.776.

Test Population

The population for this study was all of the students enrolled in seventh grade general science in the University School, Indiana University, Bloomington, Indiana.

Bloomington is a midwestern city with a population within the city limits of about thirty-two thousand, according to a census taken early in 1960.

It was originally planned that 60 students would be included in each of the two groups; but because the seventh grade enrollment was smaller than anticipated, 40 students were in the statement film group and 41 were in the question film group.

The subjects used in this study had attended sixth grade in a number of elementary schools located in a variety of school districts. Three elementary schools in Bloomington accounted for the sixth grade attendance of 58 of the 81 subjects. Of the remaining 23 subjects, nine had attended at least one of three other elementary schools in Bloomington; and 14 had attended elementary schools which were not located in Bloomington. Half of the latter group were children of students attending Indiana University.

Examination of the occupations of the parents of the subjects included in the sample indicated that they were in various socio-economic classes. Seven of the parents were listed as students at Indiana University, seven were listed as professors, and 14 as teachers. In the remaining 53 there were included merchants, stone masons, electricians, plumbers, salesmen, carpenters, tavern owners, rectors, lawyers, dairymen, meat cutters, bankers, car dealers, railroad workers, office managers,

electronic factory workers and those who were in the Army, Navy or Marines.

The I.Q.s of the students participating in the study ranged from 73 to 142 with a median I.Q. of 114. The I.Q.s were determined by scores on the California Short Test of Mental Maturity administered one week prior to the conducting of the experiment.

Division of Students into Groups

One week before the experiment was to be conducted, the writer obtained from the junior high school principal a list of the students enrolled in seventh grade general science, the name of their instructor, and the time and place of their daily class meeting.

There were four sections of general science with an enrollment of 18, 23, 21 and 21 respectively. Three sections met in the morning and one in the afternoon; each section had the same instructor.

Each student was assigned a number by giving number one to the first student listed in section one then numbering consecutively with the last student listed in section four receiving number 83. The students were divided into two groups by using a table of random numbers; then a coin was flipped to determine which group would be the question film group and which, the statement film group. Prior to the conducting of the experiment, a list of the students

belonging to each of the two groups was prepared for each section.

During the second day of the experiment, the two groups in each section needed to meet in separate rooms with the regular instructor supervising one group and the writer supervising the other. In order to minimize differences in the test results of the two groups which may have been caused by differences in supervision, a coin was flipped to determine whether the question film group or the statement film group of section one should be supervised by the instructor. Supervision of the groups was then alternated for each section thereafter.

Description of the Experiment

In order to make final preparations, five days before the experiment was conducted, the writer met with the junior high principal, the senior high principal (who was the junior high principal when earlier arrangements for the experiment had been made), and the instructor for all the seventh grade general science sections.

It was decided that the experiment should be conducted in the adjacent Education Building instead of the Junior High Building for the following reasons: (1) the temporary building used for the junior high classes was unusually hot at this time of the year; whereas, the classrooms in the Education Building were at a comfortable

temperature; (2) the two rooms available in the junior high school for the second day of the experiment were not the same two rooms for each section, differed considerably in physical make-up, and were quite far apart; whereas, two adjacent, almost identical classrooms were available in the Education Building; and (3) the students participating in the experiment would have met in classrooms in the Education Building prior to the conducting of the experiment; thus the surroundings would be familiar.

The procedures to be followed during the first and second days of the experiment were discussed with the instructor.

During the first day of the experiment, as each section met in one of the two classrooms to be used for the second day of the experiment, the pretest was given by the instructor. The students were not informed that they were participating in an experiment. The writer obtained the completed tests from the instructor after the last section had met.

The following day, as each section met in the same room in which the pretest was given, the instructor read the names of the students who were assigned to one of the film groups. Then the instructor accompanied one of the groups to the adjacent classroom while the other group remained with the writer.

Each of the rooms had almost identical projection

conditions. The screens were of the same type and size, the darkening facilities were the same, and an Eastman Pageant magnetic projector was set up in each room. Prior to the meeting of each section, the writer threaded the films in each room and made the necessary projector adjustments so that the films were ready to project with the flip of a switch. The instructor and the writer were their own projectionists.

As each of the groups met, they were told that yesterday they were given a test concerned with the basic requirements for a good planned experiment; and now they would see a film which would explain these basic requirements. Also, they were told that immediately following the film showing, they would be given a test on the content of the film. In addition, the question film group was told that there would be questions contained within the film followed by a time interval during which they should try to answer the questions to the best of their ability.

The film was projected; and immediately following the projection, the post-test was administered. Sufficient time was allowed for all students to complete all items on both the pretest and the post-test.

The retention test was administered two weeks after the post-test. It was identical to the pretest and the post-test except for rearrangement of the test parts.

CHAPTER IV

ANALYSIS OF DATA AND RESULTS

This chapter discusses the scoring of the tests and tabulation of the test results, the statistical analysis of the data, and the retention or rejection of the null hypotheses.

Scoring of the Tests and Tabulation of the Test Results

The pretest, post-test and the retention test were hand scored; and the number of correct responses for each subject was tabulated on master scoring sheets. Also recorded on the master scoring sheets were the means of the pretest, post-test and retention test scores.

Statistical Analysis of the Data

The major purpose of this study was to determine whether the students viewing the question film would make a significantly higher mean score on the post-test than the students viewing the statement film. Eight hypotheses were formulated, and the t-test and Mann-Whitney U test were used for analysis of the data.

Standard error of difference between two means. A major concern in the analysis of the data in this study was whether the observed difference between two means was of

such magnitude that it could not be attributed to chance or sampling variations alone. If it were not of this magnitude, then we would infer that the difference was the result of experimental conditions. A prime problem, then, was the determination of the reliability of the difference between two means.

Since the difference between two means is a sample statistic, and thus has a sampling distribution and a standard error, it can provide an estimate of the population difference and furnish a basis for testing hypotheses about that population.

The t-test of significance. When two groups are to be compared, the t-ratio provides a means for testing a hypothesis concerning the relationship between the mean of group one and the mean of group two. It enables the investigator to decide whether the hypotheses will be retained or rejected. It is the ratio of the difference between two means and the standard error of the difference between these means.

Degrees of freedom. In order to enter the t table, the number of degrees of freedom available in a sample set of observations needs to be known. In finding the estimate of the population variance which is necessary for determining the standard error of the mean, the mean of the sample is first calculated. The deviations of the observations from the mean are determined and since these deviations must

equal zero, the last observation is fixed. Thus, the estimate of the population variance is based on n - 1 degrees of freedom.

The Mann-Whitney U test. Since the sample size used for testing hypotheses five, six, seven and eight was small, and the writer wished to avoid the assumption of normality underlying parametric tests, the nonparametric Mann-Whitney U test was used for testing these four hypotheses. This is one of the most powerful of the nonparametric tests; and since the conditions underlying its use could be met, it was chosen in preference to other nonparametric tests.

Level of significance. Whether a difference between two means is statistically significant or not depends upon the probability that the difference could have arisen by chance. The level of significance which is acceptable is stated by the experimenter before he collects his data. Research workers use the .01 and the .05 levels of significance most frequently; but the value chosen depends on a number of factors including the purpose of the experiment, the measurement employed and the accuracy demanded. In this study, the writer set the level of significance at .05.

One and two-tailed tests of significance. When the experimenter has no more basis for believing that the mean of Group One will be greater than the mean of Group Two than he has for believing that it will be less, than the two-tailed test of significance is appropriate. This

indicates that the experimenter is interested in any difference between the two means regardless of direction. However, if the experimenter has a basis for predicting in advance of the experiment that a particular mean will be greater than another, then the one-tailed test of significance is appropriate. Stated as a null hypothesis, we would say that the mean for Group One is equal to or less than the mean for Group Two. If the null hypothesis is rejected, we would accept the alternative hypothesis than Mean One is greater than Mean Two; but evidence against the null hypothesis would be provided only when the mean of Group One is significantly greater than the mean of Group Two.

The probabilities given in the t table are for two tails of the distribution; and in the two-tailed test with a level of significance of .05, .025 of the area of the distribution will be cut off at either end. However, in the one-tailed test of significance, .05 of the area of the distribution will be cut off at either end or .10 for the two tails of the distribution. Thus, in the one-tailed test of significance with a level of significance of .05, the t table is entered at .10; and the two-tailed t is entered at .05.

Hypothesis one. There is no significant difference in the mean pretest scores of the question film group and the statement film group.

The two groups in this study were formed by a table of random numbers; and theoretically, they should not be significantly different from each other in their understanding of the four basic requirements for a good planned experiment. To test this hypothesis, the means, the sum of the squares of observations about the means, and the degrees of freedom were calculated. From this data, the standard error of the difference between the means was determined. Substituting the value of the two means and the standard error of the difference in the formula for t, the value of t was calculated. A summary of the results is given in Table 2.

TABLE 2. RESULTS OF t-TEST OF SIGNIFICANCE AS APPLIED TO HYPOTHESIS 1

Comparison	t	Significant at five per cent level
Pretest means of question film group and statement film group	.159	no

The above results indicate that there is no significant difference between the mean pretest scores of the question film group and the statement film group, thus Hypothesis One is retained.

Hypothesis two. The mean post-test score of the

question film group is equal to or less than the mean post-test score of the statement film group.

Since analysis of hypothesis one showed that the two groups could be considered as being part of the same population, testing of hypothesis two would reveal if the two groups differed significantly in their mean scores after seeing their respective films. The results are summarized in Table 3.

TABLE 3. RESULTS OF THE *t*-TEST OF SIGNIFICANCE AS APPLIED TO HYPOTHESIS 2

Comparison	t	Significant at five per cent level
Post-test means of question film group and statement film group	.128	no

The above results indicate that there is no significant difference between the post-test means of the two groups, thus Hypothesis Two is retained.

Hypothesis three. The mean post-test score of the combined experimental and control groups is equal to or less than the mean pretest score of the combined groups.

Even though the experiment was not designed to determine whether there was a significant difference between pretest and post-test results of the two groups,

it was of interest to test the above hypothesis. A summary of the results is given in Table 4.

TABLE 4. RESULTS OF *t*-TEST OF SIGNIFICANCE AS APPLIED TO HYPOTHESIS 3

Comparison	t	Significant at five per cent level
Pretest and post-test mean scores for both groups	4.66	yes

Since the value of *t* is significant at better than the .05 level of significance, Hypothesis Three is rejected and the alternative hypothesis is accepted; namely, that the mean post-test score of both groups is significantly greater than the mean pretest score of both groups.

As noted earlier, it was not a major purpose of this study to determine if significant differences between pretest and post-test scores existed; however, it should be noted that the value of *t* with 79 degrees of freedom and using the one-tailed test of significance is significant at better than the .005 level. Although it is not possible to assess the amount of difference which can be attributed to the films, it seems reasonable to infer that the films accounted for much of the difference.

Hypothesis four. The mean retention test score of

the question film group is equal or less than the mean retention test score of the statement film group.

A retention test was given two weeks after the administration of the post-test. A summary of the results is given in Table 5.

TABLE 5. RESULTS OF t-TEST OF SIGNIFICANCE AS APPLIED TO HYPOTHESIS 4

Comparison	t	Significant at five per cent level
Retention test means of question film group and statement film group	.52	no

The above results indicate that there is no significant difference between the retention test means of the two groups, thus Hypothesis Four is retained.

Hypotheses five, six, seven and eight. These hypotheses were concerned with possible significant differences between the post-test means of the statement group and the question group when analyzed within four I.Q. groupings. A summary of the results is given in Table 6.

TABLE 6. RESULTS OF THE MANN-WHITNEY U TEST AS APPLIED TO HYPOTHESES 5, 6, 7 AND 8

Comparison of the post-test means of the following I.Q. groupings in the two film groups	U	Significant at five per cent level
Above 125	47.5	no
111-125	99.5	no
95-110	39.5	no
Below 95	17.0	no

The above results indicate that there is no significant difference between the post-test means of the statement group and the question group when analyzed within the four I.Q. levels. Thus, hypotheses five, six, seven and eight are retained.

The writer thought that it would be of interest to combine the scores of the question group and statement group and compare the mean gain from pretest to post-test for each of the above I.Q. groupings. These mean gains are given in Table 7.

TABLE 7. MEAN GAIN IN SCORES FROM PRETEST TO POST-TEST FOR EACH OF FOUR I.Q. GROUPINGS

I.Q. groupings	Mean gain (pretest to post-test)
Above 125	6.55
111-125	4.79
95-110	4.31
Below 95	3.84

The above results indicate that the higher I.Q. group made larger mean gains from pretest to post-test than the lower I.Q. groups.

Examination of the means for the four categories of test items. Even though the t test showed no significant difference between the post-test means of the question group and the statement group, the writer thought that an examination of the post-test means for each of the four test item categories might indicate a sizeable difference between the two film groups in one or more of the categories. Consequently, the number of correct responses to the test items in each of the four categories were recorded, and the means calculated. The results are given in Table 8.

TABLE 8. RESULTS OF CALCULATION OF MEANS IN EACH OF FOUR TEST ITEM CATEGORIES

Requirement test items were designed to measure	Number of items	Means		Difference
		Statement group	Question group	
Two parts	15	10.225	10.146	.079
Single variable	15	10.750	11.024	.274
Many cases	6	4.200	4.672	.482
Conclusion	9	5.175	5.112	.063

The difference between the means of the statement

group and the question group in each of the test item categories were so slight that further statistical computations were not attempted.

CHAPTER V

CONCLUSIONS

The conclusions are presented with the following considerations: (1) the sample was limited and at a particular grade level; (2) the content of the film versions and the way in which the content was presented represented only one of many ways in which motion pictures could develop an understanding of the four basic requirements of a good, planned experiment; and (3) the purpose of this study was to determine the effectiveness of the two film versions per se; under different utilization procedures, the results may have been different.

1. A pretest and post-test constructed by the writer to measure an understanding of the four basic requirements for a good, planned experiment showed that the students who saw the film version containing the inserted questions did not learn significantly more than the students who saw the film version which contained no inserted questions.

2. The gain between pretest and post-test results for both groups was statistically significant at better than the .005 level of confidence. It would seem that much of this gain was due to the film presentation.

3. A retention test, which was the same as the pretest and post-test except for a different arrangement of the parts, showed no significant difference between the means of the students who saw the film version containing

the inserted questions and the students who saw the film version containing no inserted questions.

4. Comparison of the statement group and the question group by I.Q. groupings showed no significant difference between post-test means within any of the four I.Q. groupings analyzed.

5. The higher I.Q. groups made larger mean gains from pretest to post-test than the lower I.Q. groups.

6. Examination of the post-test mean scores of the statement group and the question group in each of four categories of test items indicated negligible differences.

References Mentioned in the Report

1. Allen, William H., "Research on Film Use: Student Participation," Audio-Visual Communications Review 5:423-450, Spring, 1957.

2. Atkin, J. Myron, "Critique of 59th Yearbook," Science Teacher 27:9, May, 1960.

3. Bayles, Ernest E., "Is Science Teaching Scientific?" Science Teacher 23:11-12, 63-65, February, 1956.

4. Crowell, Victor L. Jr., "The Scientific Method: Attitudes and Skills Essential to the Scientific Method and Their Treatment in General Science and Elementary Biology Textbooks," School Science and Mathematics 37:525-531, May, 1937.

5. Curtis, Francis D., "Teaching Scientific Methods--Article VI: Teaching Scientific Methods," School Science and Mathematics 34:816-819, November, 1934.

6. Davis, Frederick B., Item-Analysis Data, Graduate School of Education, Harvard University, Cambridge, Mass., 1946, 42 pp.

7. De Prospo, Nicholas D., Developing Scientific Attitudes by Responding Actively to Motion Pictures: A Study to Determine if Responding Actively to Selected Motion Pictures by Identifying the Problem Solving Skills Reenforces or Develops a Scientific Attitude in College Freshmen, Doctor's thesis, New York University, New York, 1957, 148 pp., microfilm.

8. Downing, Elliot R., "The Elements and Safeguards of Scientific Thinking," Scientific Monthly 26:231-232, May, 1928.

9. Hall, W. J., "A Study of the Methods of Teaching Science with Classroom Films," School Science and Mathematics 36:968-970, 1936.

10. Harby, S. F., Comparison of Mental Practice and Physical Practice in the Learning of Physical Skills, Human Engineering Report, SDC 269-7-27, U.S. Department of the Navy, Office of Naval Research, Special Devices Center, Port Washington, Long Island, N.Y., June, 1952, 11 pp., mim.

11. Jaspen, N., Effects on Training of Experimental Film Variables, Study II: Verbalization, "How-it-Works," Nomenclature, Audience Participation and Succinct Treatment, Technical Report SDC 269-7-11, U.S. Department of the Navy, Office of Naval Research, Special Devices Center, Port Washington, Long Island, N.Y., March, 1950, 13 pp., mim.

12. Kantor, Bernard R., An Exploratory Study of the Effects of Inserted Questions in the Body of Instructional Films, Doctor's thesis, University of Southern California, Los Angeles, 1959, 192 pp., microfilm.

13. Keeslar, Oreon Pierre, Contributions of Instructional Films to the Teaching of High School Science, Doctor's thesis, University of Michigan, Ann Arbor, 1945, 320 pp., microfilm.

14. Kurtz, Albert K.; Walter, Jeanette S.; and Brenner, Henry, The Effects of Inserted Questions and Statements on Film Learning, Technical Report SDC 269-7-16, U.S. Department of the Navy, Office of Naval Research, Special Devices Center, Port Washington, Long Island, New York, 1950, 15 pp., mim.

15. Lumsdaine, Arthur A., and May, Mark A., Learning from Films, Yale University Press, New Haven Connecticut, 1958, 357 pp.

16. Maccoby, Nathan, Some Factors Influencing the Effects of Audience Participation on Learning from a Factual Film, Human Resources Research Laboratory Memo Report 13A, Washington, D.C., U.S. Air Force, Human Resources Research Laboratories, Headquarters Command, Bolling Air Force Base, December, 1951, 46 pp., mim.

17. National Society for the Study of Education, Science Education in American Schools, 46th Yearbook, Part I, University of Chicago Press, Chicago, Ill., 1947, 306 pp.

18. Northern California Science Committee, Problem Solving Through Science, preliminary edition, May, 1959, 36 pp., unpublished.

19. Obourn, Ellsworth S., An Analysis and Check List of the Problem Solving Objective, U.S. Department of Health, Education and Welfare, Office of Education, Washington, D.C., June, 1956, 14 pp.

20. Roshal, Sol M., Effects of Learner Representation in Film-Mediated Perceptual Motor Learning, Technical Report 269-7-5, U.S. Department of Navy, Office of Naval Research, Special Devices Center, Port Washington, Long Island, N.Y., March, 1950, 13 pp., mim.

21. Rulon, Philip J., The Sound Motion Picture in Science Teaching, Harvard Studies in Education, Vol. 20, Harvard University Press, Cambridge, Mass., 1933, 236 pp.

22. Stollberg, Robert, "Problem Solving; The Precious Gem in Science Teaching," Science Teacher, pp. 225-228, 257, September, 1956.

23. Weller, Florence, "Attitudes and Skills in Elementary Science," Science Education 17:90-97, April, 1933.

APPENDIX

This is a test of your understanding of the requirements for a good experiment.

There are seven parts to the test. Each part consists of a paragraph describing or referring to an experiment and statements concerning the experiment. There are also directions for responding to the statements.

Read each paragraph carefully, then follow the directions in responding to the statements.

When you finish one part of the test go on to the next part. If you finish the entire test before the time is up, go back and check your answers.

DO NOT TURN THIS PAGE UNTIL INSTRUCTED TO DO SO.

A. John wanted to conduct an experiment to find out if sunlight causes newspapers to turn yellow. He placed three strips of newspaper in a sunny window and a week later observed that all the strips had turned yellow. John concluded that sunlight causes newspapers to turn yellow.

THE FOLLOWING STATEMENTS REFER TO THE EXPERIMENT JUST DESCRIBED. IN THE BLANKS PRECEDING THE STATEMENTS PLACE

T if the statement is TRUE.
F if the statement is FALSE.
T F if the statement could be EITHER TRUE OR FALSE.

____ 1. This is a well designed experiment except that John should have placed more strips in the window.

____ 2. The yellowing was not caused by the sunlight but by something else.

____ 3. It would have been a better experiment if John had placed some strips of newspaper in a dark place and some in a sunny window.

____ 4. John's experiment proved that sunlight causes newspapers to turn yellow.

____ 5. John should have divided many newspaper strips into two groups but only one of the groups should have been placed in the sunlight.

____ 6. John should have also placed newspaper strips where there wasn't any sunlight.

____ 7. John should have placed half of all the newspaper strips used in the experiment in one sunny window and the other half of the newspaper strips in another sunny window.

____ 8. The newspaper strips would not have turned yellow if they had been placed in the dark instead of in the sunlight.

B. A student wanted to do an experiment to compare the nutritional value of milk with that of water. He obtained two similar cages and placed a mouse in each one. Each day one mouse was given milk and bread while the other was given water and bread. After five days, the mouse on the milk and bread diet was alive and healthy while the mouse on the water and bread diet was dead.

THE FOLLOWING STATEMENTS REFER TO THE EXPERIMENT JUST DESCRIBED. IN THE BLANKS PRECEDING THE STATEMENTS PLACE

T if the statement is TRUE.
F if the statement is FALSE.
T F if the statement could be EITHER TRUE OR FALSE.

_____ 1. One mouse should have been placed where it was warm and the other where it was cool.

_____ 2. The mouse died because it was given water instead of milk.

_____ 3. This experiment proves that mice cannot live on bread alone.

_____ 4. More mice should have been used in this experiment.

_____ 5. Just because the mouse given the water and bread died doesn't mean that all mice on a water and bread diet would die.

_____ 6. It would have been a better experiment if one mouse were given water and bread and the other milk only.

_____ 7. The mice were of equal health at the beginning of the experiment.

_____ 8. The mouse on the water and bread diet would have died regardless of what he was fed.

C. Mary wanted to know if planted seeds need to be placed in light in order to sprout into plants. She filled six flower pots with rich soil and planted five bean seeds from the same package in each pot. Three of the pots she set in a warm room near a window where the sunlight could shine on them. The other three she set in a cold, dark room. All six pots were watered equally and regularly. After one week, the seeds near the window had sprouted while those in the cold, dark room had not. Mary concluded that bean seeds need light in order to sprout into plants.

THE FOLLOWING STATEMENTS REFER TO THE EXPERIMENT JUST DESCRIBED. IN THE BLANKS PRECEDING THE STATEMENTS PLACE

T if the statement is TRUE.
F if the statement is FALSE.
T F if the statement could be EITHER TRUE OR FALSE.

_____ 1. Mary would have improved her experiment if she had used rich soil in three of the pots and sandy soil in the other three.
_____ 2. All six of the pots should have been set near a window.
_____ 3. It was necessary to water all six pots equally.
_____ 4. The seeds near the window sprouted because they were in the light.
_____ 5. The temperatures in the lighted room and in the dark room should have been the same.
_____ 6. Mary claimed that her experiment proved more than it really did prove.
_____ 7. The results of this experiment would have been the same if a different kind of seed was used.
_____ 8. Mary should have planted one seed in each pot instead of five seeds as she did.
_____ 9. This experiment proves that all the seeds in the cold dark room were not as healthy as the seeds which sprouted in the warm lighted room.

D. A science student wanted to do an experiment to find out if bean seeds exert a pressure around them when they germinate. He filled a jar with bean seeds which had been soaked in water so they would germinate, then tightly sealed the top of the jar. He left the jar of seeds in a warm place overnight. Next morning he found that the jar had been burst open. He concluded that bean seeds exert pressure in germinating.

THE FOLLOWING STATEMENTS REFER TO THE EXPERIMENT JUST DESCRIBED. IN THE BLANKS PRECEDING THE STATEMENTS PLACE

T if the statement is TRUE.
F if the statement is FALSE.
T F if the statement could be EITHER TRUE OR FALSE.

____ 1. This experiment provides enough evidence to prove that bean seeds exert pressure around them when they germinate.

____ 2. The jar burst because of pressure exerted by germinating bean seeds.

____ 3. Seeds of another kind should have been mixed with the bean seeds in the same jar; then there would have been two things to compare.

____ 4. A jar full of bean seeds left dry so they could not germinate should have been included in the experiment.

____ 5. If seeds of a different kind had been used, the results would have been the same.

____ 6. This experiment should have been performed with two jars--the one that was used and an empty jar.

E. Suppose you wanted to do an experiment to find out whether moss plants grow better in a sunny place or in a shady place.

THE FOLLOWING ARE SUGGESTIONS THAT MIGHT BE FOLLOWED IN DOING THE EXPERIMENT. FIRST, READ ALL OF THE SUGGESTIONS, THEN PLACE A CHECK MARK (✓) BEFORE EACH SUGGESTION THAT YOU THINK WOULD BE NECESSARY TO FOLLOW IN DOING THE EXPERIMENT.

_____ 1. Obtain one sample of each of several different kinds of healthy moss plants.

_____ 2. Do the experiment using two groups of moss plants. Place the most healthy plants in one group and the least healthy in the other group.

_____ 3. Divide the moss plants into two groups, place both groups in a sunny place and compare the results.

_____ 4. Water some of the moss plants but not the others.

_____ 5. Put some moss plants in a sunny place and others in a shady place.

_____ 6. Have all of the conditions the same for all of the plants with which you experiment except for the kind of soil in which they are grown.

F. A general science class of thirty students decided to find out by experimenting whether mold spores grow better in a moist substance or in a dry substance.

THE FOLLOWING ARE THE SUGGESTIONS THAT THEY MADE FOR DOING THE EXPERIMENT. FIRST, READ ALL OF THE SUGGESTIONS, THEN PLACE A CHECK MARK (✓) BEFORE EACH SUGGESTION THAT YOU THINK WOULD BE GOOD TO FOLLOW IN DOING THE EXPERIMENT.

_____ 1. Let half of the class put mold spores on dry bread and the other half on moist cheese. Then compare the results.

_____ 2. The class should experiment with more than one kind of mold.

_____ 3. Have all the members of the class try to grow mold on dry substances then observe the results.

_____ 4. Each member of the class should try to grow mold on both a moist and a dry substance.

_____ 5. Each member of the class should have all the parts of his experiment the same except for moistness and dryness.

_____ 6. Each student should keep his samples side by side during the experiment.

_____ 7. If moist substances are used in the experiment they should be covered with a glass but the dry substances should not be covered.

_____ 8. The class should try to grow mold on more than one kind of substance.

G. Suppose that you wanted to do an experiment to find out if moisture is necessary for iron to rust.

DESCRIBE THE EXPERIMENT THAT YOU WOULD DO.